B1

1) Apparatus for the conversion of energy comprising:

a) a source of energy;

b) an emitter electrode connected to said source of energy;

c) a collector electrode,

d) an electrical circuit connecting said electrodes; and

e) manipulating means for controlling the distance separating said electrodes , connected to either or both of said electrodes;

wherein said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode.

B2

4) The apparatus of claim 2 wherein said housing is flexible to allow the movement of said manipulating means and of said electrodes.

B3

7) The apparatus of claim 1 further comprising measuring means to enable the measurement of the distance separating said electrodes.

8) The apparatus of claim 1 wherein said manipulating means is selected from the group consisting of: piezo-electric, electrostrictive, and magnetostrictive actuators.

9) The apparatus of claim 1 wherein said manipulating means comprises multiple actuators.

10) The apparatus of claim 9 comprising means for controlling said multiple actuators independently.

13) The apparatus of claim 1, wherein the conversion of energy is the conversion of thermal energy to electrical energy, wherein said source of energy comprises a source of thermal energy, and wherein said apparatus further comprises:

a) a first thermal interface thermally connecting said source of energy to said emitter electrode;

b) a second thermal interface thermally connecting a heat sink means to said collector electrode;

B3 cncld.

c) an electrical load, electrically connected by said circuit between said collector electrode and said emitter electrode.

14) The apparatus of claim 13 wherein said source of thermal energy is of solar origin.

15) The apparatus of claim 1, wherein the conversion of energy is the conversion of light energy to electrical energy, wherein said source of energy comprises a source of photons, directed at said emitter electrode for impacting the electrons in said emitter electrode and for causing said electrons to tunnel to said collector electrode, and wherein said apparatus further comprises an electrical load, electrically connected by said circuit between said collector electrode and said emitter electrode.

16) The apparatus of claim 15 wherein said conversion of energy additionally comprises the conversion of heat energy to electrical energy and wherein said source of photons is also a source of thermal energy.

17) The apparatus of claim 1, wherein the conversion of energy is the conversion of electrical energy to heat pumping capacity, wherein said source of energy comprises an electrical power supply, and wherein said apparatus further comprises:

a) a heat source and a heat sink, wherein said heat source may be cooler than said heat sink, and wherein said heat source is thermally connected to said emitter electrode and said heat sink is thermally connected to said collector electrode, and,

b) means for applying a voltage bias to said electrodes for causing said emitter electrode to emit electrons originating from above the Fermi level via quantum mechanical tunneling, whereby heat pumping is enabled.

23) A first and a second electrode for use in a diode device, each electrode having a surface for positioning facing the other electrode, wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode.

B4

26) The diode device of claim 24 wherein the electrodes are positioned 100 angstroms apart or closer.

27) The diode device of claim 24 further comprising manipulating means for controlling the spacing between said electrodes.

B5

31) The two electrodes of claim 29 wherein said electrode for higher temperature operation comprises titanium.

32) The two electrodes of claim 29 wherein said other electrode comprises aluminum.

33) A method for making the pair of electrodes of claim 23 comprising the steps of:

a) providing a first electrode with a substantially flat surface fabricated from a first material;

b) coating said surface of said first electrode with a thin layer of a second material;

c) coating said layer of said second material with a layer of a third material, said third material forming a second electrode;

d) separating said first electrode and said third material from one another, in a manner non-destructive to said first electrode and said third material, wherein surface features of said second electrode match surface features of said first electrode;

e) removing said second material.

B6

35) The method of claim 33 in which said second material is removed by a process comprising heating to a temperature greater than that of the melting temperature of said second material but lower than the melting temperature of said first electrode and of said third material, so as to evaporate said second material.

36) The method of claim 33 additionally comprising the steps of:

a) attaching said first electrode and said third material to controllable positioning means;

b) separating said first material from said third material in step (d) of claim 33 using said controllable positioning means, so that surface features on the surface of said first electrode are maintained in spatial orientation with said matching surface features on said second electrode.

Please append new claims 43 – 68 as follows:

B7

43) The apparatus of claim 2 further comprising a thermal interface thermally connecting said housing to said collector electrode.

B1 cont.

44) The apparatus of claim 43 wherein said thermal interface comprises a thermally conductive metal powder disposed between said collector electrode and said housing.

45) The apparatus of claim 44 wherein said metal powder is aluminium powder.

46) The apparatus of claim 2 further comprising a thermal interface thermally connecting said source of energy to said emitter electrode.

47) The apparatus of claim 46 wherein said thermal interface comprises a thermally conductive metal powder disposed between said emitter electrode and said source of energy.

48) The apparatus of claim 47 further comprising an extendable depository for said metal powder, for providing containment for the metal powder in such instances when the emitter electrode is moved by said manipulating means toward said source of energy.

49) The apparatus of claim 46 wherein said metal powder is aluminium powder.

50) The apparatus of claim 7 wherein said measuring means comprises apparatus for measuring capacitance.

51) The apparatus of claim 7 wherein said measuring means comprises apparatus for measuring tunneling current.

52) The apparatus of claim 7 wherein said measuring means comprises optical interferometry.

53) The apparatus of claim 1 wherein said distance separating said electrodes is controlled at an initial value by said controlling means.

54) The apparatus of claim 1 wherein said distance separating said electrodes is 10 angstroms.

55) The apparatus of claim 1 wherein said distance separating said electrodes is 100 angstroms or less.

56) The apparatus of claim 1 wherein said distance separating said electrodes is 200 angstroms or less.

57) The apparatus of claim 1 wherein a region between said electrodes is evacuated.

58) The apparatus of claim 1 wherein a region between said electrodes comprise an inert gas.

59) The apparatus of claim 58 wherein said inert gas is argon.

60) The diode device of claim 26 wherein an inert gas fills a region between said electrodes.

61) The diode device of claim 27 wherein said manipulating means is selected from the group consisting of: electroactive, magnetostrictive, electrostrictive, and piezo-electric means.

B7 cancel.

62) The method of claim 34 further wherein said inert gas is argon.

63) The method of claim 33 in which said second material is removed by a method comprising introducing a solvent to dissolve said first material.

64) The method of claim 33 in which said second material is removed by a method comprising introducing a reactive solution which reacts with said first material and dissolves it.

65) The method of claim 33 in which said second material is removed by a method comprising applying a vacuum to pump out any materials except said first electrode and said second material.

66) The method of claim 35 wherein said second material has a melting temperature approximately 0.8 of a melting temperature of said first material and said third material.

67) The method of claim 35 wherein said second material comprises lead.

68) The method of claim 35 wherein said third material comprises aluminum.

REQUEST FOR RECONSIDERATION

Applicants acknowledge with appreciation that the Examiner has indicated that claim 6 is allowed.

Applicants have amended the title to render it clearly indicative of the invention to which the claims are directed.

Applicants have amended the specification to include the language of claims 25 and 26 – no new material has been added.

Applicants are amending claims 1, 4, 7-10, 13-17, 23, 26, 27, 31-33, 35 and 36 so as to more clearly point out the distinctive features of the invention, to correct minor errors, and to use claims language that has antecedent basis in the specification.

No new matter is added by these amendments and cancellations and they are fully supported by the specification as filed. Applicants respectfully request entry of these amendments and cancellations.

Further, Applicants respectfully request that the Examiner reconsider the above-captioned patent application in view of the foregoing amendments and the following remarks.

REMARKS

1. Objections and Rejections

The Office Action objects to the title as not being descriptive of the claimed invention. Claims 18, 21 and 22 stand rejected under 35 USC 112 as containing subject matter that was not described in the specification. Claims 1, 2, 4, 7, 8-16, 23, 24, 27 and 28 stand rejected under 35 USC 102; claims 3, 5, 17, 25, 26, 29-37 stand rejected under 35 USC103.

2. Objection to the title

Applicants have amended the title as requested by Examiner: Applicants respectfully request Examiner to withdraw rejection of the title.

3. 35 USC 112

Claims 18, 21 and 22 have been withdrawn without prejudice.

4. 35 USC 102

For rejection under 35 U.S.C. 102, the reference must teach every aspect of the claimed invention either explicitly or impliedly. Any feature not directly taught must be inherently present.

(a) Kennel

Applicants have amended claim 1 to more clearly emphasize the distinctive features of the invention. In particular, a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

Claims 1, 2 and 7 stand rejected by Examiner on the basis that Kennel's teaching of "a thermal conversion device having a source of electron tunneling (voltage source) connected to the emitter which when pulsed, produced an electron tunnel to the anode **104**" reads onto Applicants' claim limitations.

Applicants respectfully traverse, because Kennel does not teach in either an express or implied manner that electrons tunnel from emitter to collector. Kennel teaches that electrons are injected

into the diamond material from the substrate (see column 2 lines 16-19; column 5 lines 42-46; column 8, 18-20). Kennel also teaches that the efficiency of electron emission from the negative electron affinity diamond emitters is improved by effectively increasing the conductivity of the diamond by injecting charge carriers via a heavily doped n-type semiconductor junction (column 7 line 50 – column 8 line 24). This injection process is between the substrate and the diamond film on it. Electrons are subsequently emitted from the diamond into the space between the electrodes, and travel to the anode. Kennel therefore does not teach, either explicitly or impliedly, that electrons tunnel from the substrate to the anode **104** – he teaches that electrons are injected from the substrate into the diamond film, and are emitted from the diamond film into the inter-electrode space, and subsequently enter the anode. In Applicants' invention, electrons tunnel from cathode to anode (emitter to collector); theory indicates that they are not to be found in the intervening space. Applicants respectfully request Examiner to withdraw the rejection of claims 1, 2 and 7 as being anticipated by Kennel.

Claims 1, 2 and 7 also stand rejected on the basis that Kennel's teaching "that manipulator **108** includes some form of means for assessing the electrode distance" is inherent.

Except when describing how the commencement of the emission of electrons is achieved (see column 6, lines 14-23), Kennel makes no reference at all to the separation between the electrodes. It is clear, that while manipulator **108** allows the two electrodes to be brought into contact to initiate electron emission, it plays no other role in the operation of the device. Kennel does not teach anything at all about the separation of the electrodes; it cannot therefore be inherent that manipulator **108** includes some form of means for assessing the electrode distance, as there is no teaching on the magnitude of this distance. Applicants respectfully request Examiner to withdraw the rejection of claims 1, 2 and 7 as being anticipated by Kennel.

(b) Hatsopoulos and Gyftopoulos (H&G)

Claims 1, 2, 4, 7, 23 and 24 stand rejected by Examiner on the basis that H&G's explicit teaching of a thermionic diode having a flat emitter and collector, a manipulator, a vacuum housing that is flexible to allow the movement of electrodes, and an electrode adjustment means activated by a human, and H&G's inherent teaching that the converter is attached to an electrical load, and the ability of the human to determine the spacing of the electrode, teaches every aspect of the claimed invention.

Applicants have amended claim 1 to more clearly emphasize the distinctive features of the invention. In particular, a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

Examiner has not demonstrated how this aspect of the claimed invention is taught by H&G, either explicitly or impliedly, nor has Examiner indicated how it is inherently present in the teachings of H&G. Examiner has not indicated how thermionic tunneling reads onto the claim limitations. Applicants respectfully request Examiner to withdraw the rejection of claims 1, 2, 4 and 7 as being anticipated by H&G.

Applicants have amended claim 23 to more clearly emphasize the distinctive features of the invention. In this regard, a further distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

Examiner has not demonstrated how H&G teach electrodes which comprise matching topological features to one another, either in an explicit or implied fashion, nor has Examiner indicated how this feature is inherently present in the teachings of H&G. Applicants respectfully request Examiner to withdraw the rejection of claims 23 and 24 as being anticipated by H&G.

(c) DiMatteo

Claims 1, 2 8-16, 23, 24 and 27 stand rejected by Examiner on the basis that DiMatteo's explicit teaching of a energy converter having an emitter connected to a heat source, a collector connected to a cool source, a circuit and piezo-electric actuators, and DiMatteo's inherent teaching that the housing is flexible and allows adjustment of the electrodes, and that there is a control means for the electrodes.

Applicants have amended claim 1 to more clearly emphasize the distinctive features of the invention. In particular, a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

Examiner has not demonstrated how DiMatteo teaches this aspect of the claimed invention, either explicitly or impliedly, nor has Examiner indicated how it is inherently present in the teachings of

DiMatteo. Applicants respectfully request Examiner to withdraw the rejection of claims 1, 2 and 8-16 as being anticipated by DiMatteo.

Applicants have amended claim 23 to more clearly emphasize the distinctive features of the invention. In this regard, a further distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

Examiner has not demonstrated how DiMatteo teaches electrodes that comprise matching topological features to one another, either in an explicit or implied fashion, nor has Examiner indicated how this feature is inherently present in the teachings of DiMatteo. Applicants respectfully request Examiner to withdraw the rejection of claims 23, 24 and 27 as being anticipated by DiMatteo.

(d) Rason

Claims 23 and 28 stand rejected by Examiner on the basis that Rason's explicit teaching of a diode with flat matching surfaces, and Rason's inherent teaching that different materials have differing coefficients of thermal expansion

Applicants have amended claim 23 to more clearly emphasize the distinctive features of the invention. In this regard, a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

In Figures 9 and 11 of Rason, sectionalized views of diode batteries in accordance with Rason's invention are disclosed. The emitter and collector of each embodiment are cylindrical, and therefore have a curved surface, and not a flat surface. In Fig 9, Rason teaches that emitter **86** and collector **94** surfaces may be made from identical materials (TaOCs) to prevent components of the emitter from poisoning the collector (column 16, lines 2-9). It is to be noted that Rason is not teaching that surface features of one electrode match surface features of the other electrode: they are clearly not because the collector surface has a larger surface area than the emitter surface, because the collector surface entirely surrounds the emitter surface. Also, in relation to Fig 11, emitter **138** may be made from oxygenated tantalum or oxygenated tungsten, and the collector **150** may be cesiated silver oxide (column 17, lines 43-66); there is no mention in this embodiment of identical

surfaces: if Rason was teaching that surface features of one electrode match surface features of the other electrode, it would be mentioned for Fig 11 also.

No where does Rason teach that surface features of one electrode match surface features of the other electrode. Applicants respectfully request Examiner to withdraw the rejection of claims 23 and 28 as being anticipated by Rason.

5. 35 USC 103

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure.

The initial burden is on the examiner to provide some suggestion of the desirability of doing what the inventor has done. "To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." Ex parte Clapp, 227 USPQ 972, 973 (Bd.Pat. App. & Inter. 1985). See MPEP § 2144 - § 2144.09 for examples of reasoning supporting obviousness rejections.

(a) Claim 3 rejection

Claim 3 stands rejected under 35 USC 103(a) as being unpatentable over H&G, Kennel, or DiMatteo in further view of Rason.

Claim 3 is dependent on claim 1, and a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

As recited above, neither H&G, Kennel, nor DiMatteo teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claim 3 under 35 USC 103(a).

(b) Claim 5 rejection

Claim 5 stands rejected under 35 USC 103(a) as being unpatentable over H&G, Kennel, or DiMatteo in further view of Yasuda.

Claim 5 is dependent on claim 1, and a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

As recited above, neither H&G, Kennel, nor DiMatteo teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claim 5 under 35 USC 103(a).

(c) Claim 17 rejection

Claim 17 stands rejected under 35 USC 103(a) as being unpatentable over DiMatteo in further view of Cox.

Claim 17 comprises the apparatus of claim 1, and a distinguishing structural feature of Applicants' invention is that "said distance separating said emitter electrode and said collector electrode is sufficiently small for electrons to tunnel from said emitter electrode to said collector electrode" (see claim 1).

As recited above, DiMatteo does not teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claim 17 under 35 USC 103(a).

(d) Claims 25 and 26 rejection

Claims 25 and 26 stand rejected under 35 USC 103(a) as being unpatentable over DiMatteo or H&G.

Claims 25 and 26 are dependent on claim 23, and a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

As recited above, neither DiMatteo nor H&G teaches this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claim 25 and 26 under 35 USC 103(a).

(e) Claims 29-32 rejection

Claims 29-32 stand rejected under 35 USC 103(a) as being unpatentable over Rason, in further view of Richards and Edelson.

Claims 29-32 are dependent on claim 23, and a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

As recited above, Rason does not teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claims 29-32 under 35 USC 103(a).

(f) Claims 33 and 35 rejection

Claims 33 and 35 stand rejected under 35 USC 103(a) as being unpatentable over Rason, in further view of Cox.

Claims 33 and 35 are a method of fabricating the pair of electrodes of claim 23, and a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

As recited above, Rason does not teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claims 33 and 35 under 35 USC 103(a).

(g) Claim 34 rejection

Claim 34 stands rejected under 35 USC 103(a) as being unpatentable over Rason, in further view of Cox.

Claim 34 is a method of fabricating the pair of electrodes of claim 23, and a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

As recited above, Rason does not teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claim 34 under 35 USC 103(a).

(h) Claims 36 and 37 rejection

Claims 36 and 37 stand rejected under 35 USC 103(a) as being unpatentable over Rason and Cox, in further view of DiMatteo.

Claims 36 and 37 are a method of fabricating the pair of electrodes of claim 23, and a distinguishing feature of Applicants' invention is a "first and second electrode ... having a surface ... wherein said surfaces are substantially flat and wherein surface features of one electrode match surface features of the other electrode" (see claim 23).

As recited above, Rason and DiMatteo do not teach this aspect of the invention, and Applicants respectfully request Examiner to withdraw the rejection of claims 36 and 37 under 35 USC 103(a).

CONCLUSION

Applicants respectfully submits that this application, as amended, is in condition for allowance, and such disposition is earnestly solicited. If the Examiner believes that discussing the application with one of the Applicants over the telephone might advance prosecution, Applicants would welcome the opportunity to do so.

Respectfully submitted,

A. Tav

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